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I, KIM MARSHALL, MANAGER EXAMINATION SUPPORT AND SALES,
hereby certify that the annexed is a true copy of the Provisional specification in
connection with Application No. PP 4117 for a patent by FLUID TECHNOLOGY
(AUST) LIMITED filed on 16 June 1998.

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A handwritten signature in cursive script, appearing to read "Kim Marshall".

KIM MARSHALL
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AUSTRALIA

Patents Act 1990

ORIGINAL

PROVISIONAL SPECIFICATION

ADJUSTABLE REGULATOR

The invention is described in the following statement:

ADJUSTABLE REGULATOR

FIELD

The present invention relates to a fluid regulator having an adjustable pressure and/or fluid flow, and/or rate of flow output. The present invention also
5 relates to a system for applying a fluid to a surface using an adjustable fluid regulator. The present invention has particular but not exclusive application to the dispensing of agricultural chemicals.

CROSS REFERENCE

Reference is made to co-pending Australian patents, being application
10 No. PP2909 entitled Fluid Regulator for an Aerosol; application No. PP2910 entitled Fluid Regulator for a Trigger Pump; application No. PP2908 entitled 2 Part Regulator; and application No. PP2907 entitled Diaphragm Regulator; all filed on 9 April 1998 by the present applicant, and hereinafter referred to respectively as Aerosol Application, Trigger Pump Application Diaphragm
15 Application and 2 Part Regulator. The disclosures contained in these applications are incorporated herein by reference.

BACKGROUND

Pressure regulators can be used in the regulation of the outlet pressure and/or fluid flow from such devices as fluid dispensers for agricultural chemicals.
20 An example of this type of regulator is disclosed in US patent 5,035,260, titled Line Pressure Regulator, filed 22 November 1989 which is hereby incorporated by reference.

In dispensing fluids, regulators incorporating flow regulating diaphragms may be used. Typically, these diaphragms have the fluid to be dispensed on
25 one side, and a spring on the other. This method has been found to be suitable for regulating the flow of fluid close to a single desired output pressure and/or flow rate for a variable input pressure. However if it is desired to change the output pressure and/or flow rate, then usually the stiffness of the diaphragm or spring needs to be adjusted, which has been difficult to achieve.

30 When dispensing fluids for agricultural use, such as fertiliser or pesticide, it is desirable that the amount dispensed per unit area be well controlled. A problem with dispensing such agricultural products is that commonly they are

dispensed from a moving vehicle, such as a tractor, which will have a variable speed over the ground onto which the material is to be dispersed. As the speed of the vehicle varies, the fluid, which is typically dispensed from a vehicle at a constant rate per unit of time, will vary in its concentration per unit area over the ground. Typically, the vehicle will incorporate a boom having multiple fluid dispensers, and any change in speed in the vehicle will result in a wide area having a concentration of fluid per unit area different to that which is desirable. For example, if a tractor moves over the ground at 5 km/h, having a 10 metres wide boom dispensing a total of 10 litres of fluid per minute, then the amount of fluid dispensed is 12 ml per square metre. If the speed of the tractor rises slightly to 6.5 km/h, then the concentration of fluid per unit area will drop to 9.2 ml per square meter, which may not be sufficient.

A further problem in attempting to combat this problem is that the control mechanisms needed to vary the output of the regulators have been complex and expensive. Typically, a boom type dispenser may have 10 or more spray heads, and each one needs to be controlled accurately. In order to achieve this, costly regulating equipment has been used.

SUMMARY OF THE INVENTION

The present invention has as an object to alleviate at least one disadvantage associated with the prior art. A further object of the present invention is to provide an adjustable fluid regulation device that is of simple construction, while having tolerances that can be achieved using known mass production techniques.

The present invention also seeks to reduce the number of parts required in an adjustable regulator.

Another object of the present invention is to provide a relatively inexpensive means of adjusting and regulating the pressure and/or flow of fluid between two or more predetermined levels.

Another object of the present invention is to provide means of adjusting the output of a regulator without substantial modification to the regulator.

A still further object of the present invention is to control the rate of application of fluid to a surface by varying the rate of fluid flow from an applicator

according to the speed of the applicator over the surface, thus keeping the amount of fluid applied to the surface substantially constant.

In one aspect, the present invention relates to an adjustable fluid regulator including a spring diaphragm, which controls the output of the fluid
5 from the regulator, wherein one side of the diaphragm is exposed to the fluid and the other side of the diaphragm is exposed to a source of pressure. This is based on the concept of changing the regulation characteristics of a regulator by applying an external biasing force.

Preferably the adjustable source of pressure is connected to one or more
10 adjustable fluid regulators. This allows the control of a number of fluid regulators from a single source of pressure and a single controller.

Preferably, the adjustable fluid regulators are connected to a controllable source of variable pressure by conduits. This allows the adjustable fluid regulators to be controlled from a single point, thus making the control easier
15 and cheaper.

Accordingly, in another aspect, the present invention relates to an apparatus for controlling the rate of fluid flow from one or more fluid dispensers moving over a surface, comprising:

- a fluid regulator;
- 20 a sensor for detecting the speed of the dispensers over the surface;
- an adjustable pressure generator; and
- a control means,

wherein the regulator includes a diaphragm which adjusts the flow rate of fluid from the dispensers, and the sensor detects the speed of the dispensers
25 over the surface and adjusts the pressure on one side of the diaphragm to control the rate of fluid flowing from the dispensers, dependant on that speed.

This is based on the concept of controlling the bias applied to a regulator in such a way that the regulator characteristics in operation serve to enable output of a dispenser in dependence of the speed of the dispenser over a
30 surface, to provide a more even coverage.

This allows an easy and fast method of controlling the output of an outlet.

The present invention also provides a method of adjusting the rate of fluid

flow from one or more dispensers having a diaphragm regulator wherein the speed of the dispenser over the surface varies, by:

measuring the speed of the dispenser relative to the surface; and

varying the pressure on one side of the diaphragm to control the output of

5 fluid from the dispenser.

In this way the fluid flow can be controlled to provide a more even coverage of fluid per unit area of surface.

Preferably there is more than one dispenser moving over the surface.

This provides a wide surface coverage for a single pass.

10 More preferably, each dispenser has a regulator. This allows each dispenser to be regulated thus providing an even flow of fluid and thus the delay between varying the pressure behind the diaphragm and the fluid exiting the dispenser is reduced.

In another form, the adjustable fluid regulator includes a number of
15 nozzle dispensers attached to a mechanism that allows the selection of an individual nozzle. As the present invention is to be used over a large range of fluid flow rates, it has been found to be advantageous to have a selection of nozzles to optimise the dispersal of the fluid over a range of flow rates.

PREFERRED EMBODIMENTS

20 One of the preferred embodiments of the present invention will now be described with reference to the accompanying diagrams, wherein:

Figure 1 is an isometric view of the adjustable pressure regulator system of the present invention;

Figure 2 is a sectional side view of a dispenser of the adjustable pressure
25 regulator system shown in figure 1; and

Figure 3 is a close up of the dispenser of the adjustable fluid regulator shown in figure 1.

Figure 4 is a side view of the adjustable fluid regulator shown in figure 2, having two nozzles and a carousel.

30 The adjustable pressure regulating system 10 as shown in figure 1 includes a supply tank 12, attached to a pressure pump 14, by fluid lines 16 which supply the pump 14 with fluid. The fluid lines 16 also include a pressure

relief valve 18, which prevents the pressure in the lines from exceeding a preset maximum. Fluid flows along the fluid line 16 to a manifold 17, to which a number of dispensers 20 are attached. The dispensers each contain a regulator 22 which regulates the rate of flow of fluid from the dispenser 20.

5 The regulator 22 consists of a spring diaphragm 24 attached to a spindle 26 as best seen in figure 2. The spindle 26 is in a housing 28 to form a regulator 30. At the end of the spindle 26 is a poppet valve 32 which prevents fluid from flowing out an outlet 34 of the dispenser when the pressure drops below a preset minimum. Also attached to each regulator 22 is a pressure line 40 which
10 connects the regulator 22 to a pressure generator 41. The pressure in the lines 40 is generated by a pressure source 41 such as a pump and regulated by an adjustable master pressure regulator 44. The master pressure regulator 44 is controlled by a controller 46, which receives input from a speedometer 48 as to the speed of the dispenser in relation to the ground.

15 In use, the speedometer 48 relays the speed of the vehicle to the controller 46, which has the amount of fluid needed to be dispersed per unit area pre-programmed. The controller then deduces the rate at which the fluid will need to flow from the dispenser 20 given the speed of the vehicle. Once the flow rate has been determined, the controller then computes the pressure
20 required in the lines to adjust the flow rate of each dispenser to that required. It is envisaged that each system will include either an algorithm or a look up table comparing output flow rates to control pressures within a given range. The control pressure will then be adjusted to provide an appropriate pressure behind each diaphragm, thus adjusting the flow rate. This process happens in
25 real time, for example, with the controller sampling the reading from the speedometer at regular intervals to keep the flow rate correct compared to the speed of the vehicle. It should be understood that there is a correlation between the speed of the vehicle and the pressure supplied to control the regulators.

Boom sprayers are often required to spray a range of concentrates at
30 different pre-determined dilution ratios, and at different flow rates depending on the environmental conditions. This high order dispensing requirement necessitates the selection and use of one of a range of nozzles for the optimum

spray application for the different combinations that may occur.

Currently, a considerable number of boom sprayers are fitted with mechanisms for changing nozzles, such as carousels at each dispensing position that have alternative nozzles located on them. Alternatively, the boom
5 may be rotatable, and have a number of nozzles radially spaced along the length of the boom. The boom or carousels can be rotated to allow each of the nozzles to be selected. The dispenser 20 may include one or more nozzles.

The different nozzles are likely to require different flow rates for optimum spray application and therefore the use of an adjustable regulator allows for the
10 necessary variation to be accomplished in a quick and economical way.

In one embodiment, shown in figure 4, nozzles 50 and 52 are attached to a carousel 54 which is fitted to the dispenser 20. This arrangement allows the fluid dispensed to be sprayed over an area at the optimum rate for a particular nozzle. Alternative fluids, requiring different spray rates, can be accommodated
15 quickly by rotating the carousel to allow a more suitable nozzle to be used. The use of an adjustable regulator in such an arrangement allows the nozzles to each operate at their optimum flow rate, thus ensuring that the rate of fluid flow is controlled, but also that the fluid is dispensed from the nozzle in an efficient manner, i.e. not too slow, where insufficient pressure may cause the fluid to
20 trickle from the nozzle instead of covering a wide area.

In the present invention, the speed of the surface relative to the dispenser could be measured either separately or taken from means already in place on the vehicle. The pressure behind the diaphragm is preferably from a compressed gas, such as air which allows the diaphragm to move and thus
25 regulate pressure. The pressure in the pressure lines may be from a compressible fluid, such as a gas, or an incompressible liquid, such as hydraulic fluid. In the case of the pressure being provided by an incompressible liquid, an interface between the gas and liquid may be required.

An example of an adjustable pressure regulating system that may be
30 used with the present invention, for example, when mounted onto a tractor, is described below. A compressed air cylinder the same or similar to those used in industry is coupled to an adjustable pressure regulator as commonly used

with such cylinders. The speed of the tractor can be determined from the speedometer drive cable and the information can be conveyed electrically to the controller. The controller can then look up the required pressure for that particular tractor speed and fluid output requirement in a look up table, and
5 output the result as a voltage. This voltage output from the controller may be used to vary the output pressure of the variable pressure regulator through a motor which controls the output pressure of the adjustable regulator. The amount of air used by the system is relatively small and therefore the system can be a total loss system, wherein the lines have a bleed off valve which
10 continuously bleeds of air to the atmosphere. In this way the pressure regulator can keep the pressure in the line to the required level by constantly supplying air to the lines, and if a lower pressure is required, the regulator stops or decreases the air supply and the pressure in the lines automatically falls, until the pressure is at the desired level whereupon the pressure regulator begins to
15 supply enough air to the lines to maintain the desired pressure level. To increase the pressure levels in the lines, the pressure regulator simply supplies more air. Obviously other control systems will be apparent to the skilled addressee, and there are many different types of control systems that may be employed with the present invention, which is not intended to be limited to a
20 specific method of control.

Further the present invention is easily adaptable for conveyor belts moving relative to fixed dispensers, wherein the measurement of the speed of the conveyor belt determines the rate at which fluid is dispensed.

The advantages of the present application are as follows:

- 25 an adjustable regulator of simple construction, with few parts;
a simple method of adjusting and controlling the flow from a flow regulator; and
a simple apparatus for controlling the rate of fluid dispensed over a surface from a dispenser moving relative to the surface.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. An adjustable fluid regulator including a spring diaphragm for controlling the output of the fluid from the regulator, wherein one side of the diaphragm is exposed to the fluid and the other side of the diaphragm is exposed to a source of pressure.
2. The adjustable fluid regulator of claim 1 including a balanced regulator.
3. The adjustable fluid regulator of claim 1 or 2 wherein the source of pressure is adjustable.
4. The adjustable fluid regulator of any one of claims 1 to 3 wherein the source of pressure is connected to at least one adjustable fluid regulator.
5. The adjustable fluid regulator of any one of claims 1 to 4, which are connected to a controllable source of variable pressure by conduits.
6. The adjustable fluid regulator of any one of the preceding claims wherein the output of fluid from the regulator flows through a nozzle which is mounted on the regulator by a carousel.
7. The adjustable fluid regulator of claim 6 wherein there are a number of nozzles mounted to the carousel.
8. An apparatus for controlling and adjusting the rate of fluid flow from one or more fluid dispensers moving over a surface, comprising:
 - a fluid regulator;
 - a sensor for detecting the speed of the dispensers over the surface;
 - an adjustable pressure generator; and
 - a control means,

wherein the regulator includes a diaphragm which adjusts the flow rate of fluid from the dispensers, and the sensor detects the speed of the dispensers over the surface and adjusts the pressure on one side of the diaphragm to control the rate of fluid flowing from the dispensers, dependant on that speed.

9. The apparatus of claim 8 which also includes a number of nozzles mounted to the dispenser by a mechanism that allows different nozzle types to be selected.

10. A method of adjusting the rate of fluid flow from one or more dispensers having a diaphragm flow regulator wherein the speed of the dispenser over the surface varies, by:

measuring the speed of the dispenser relative to the surface; and

varying the pressure on one side of the diaphragm to control the output of fluid from the dispenser in response to the speed of the dispenser.

11. The method of claim 10 wherein there is more than one dispenser moving over the surface.

12. The adjustable fluid regulator of any one of the preceding claims wherein each dispenser has a regulator.

DATED THIS 15TH day of June, 1998

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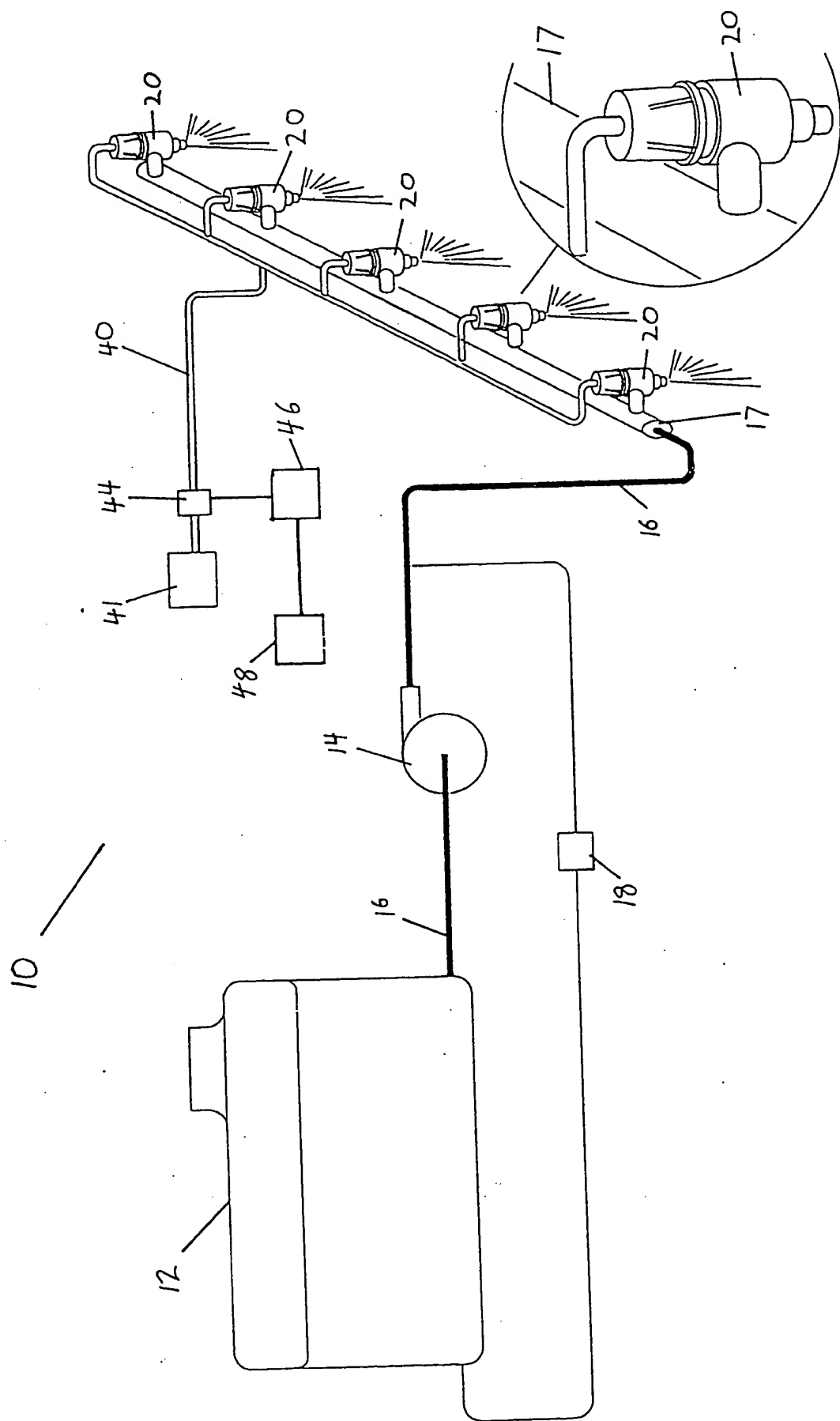
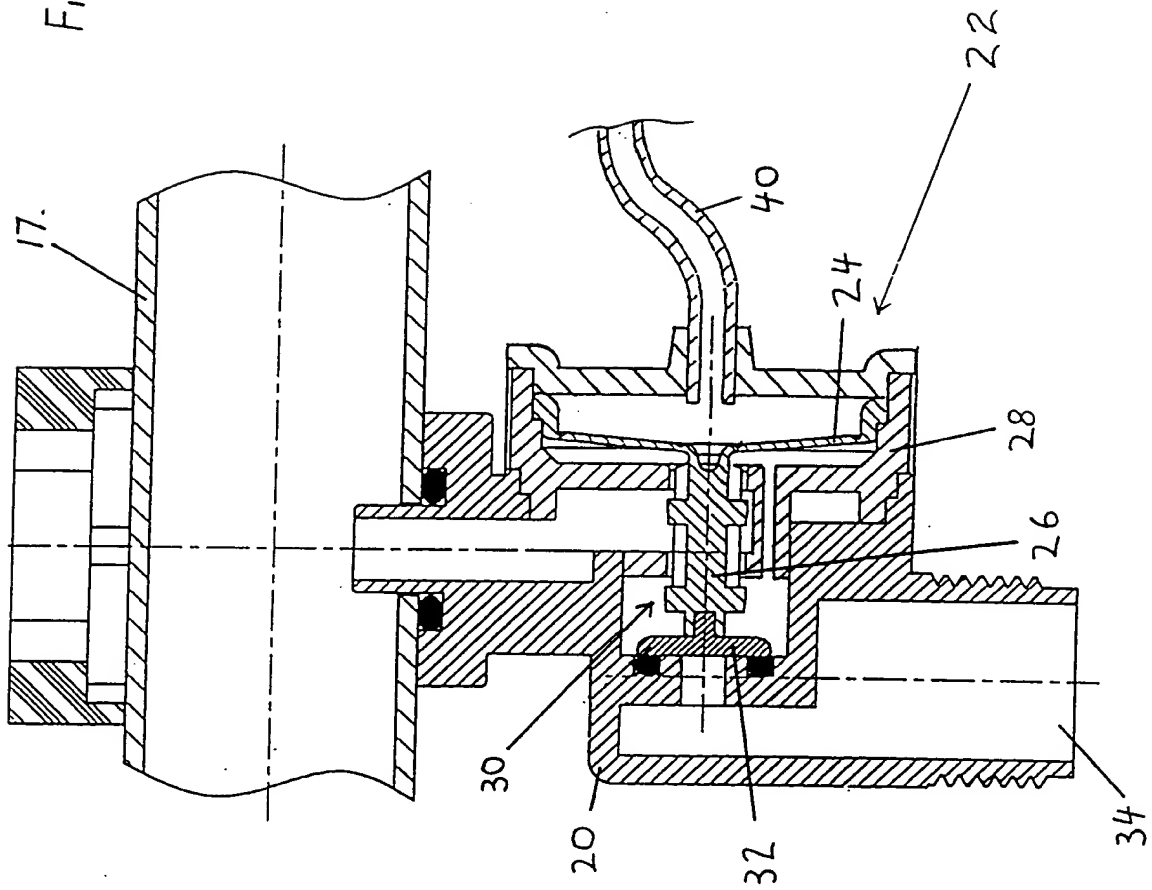


Figure 3

Figure 1

Figure 2



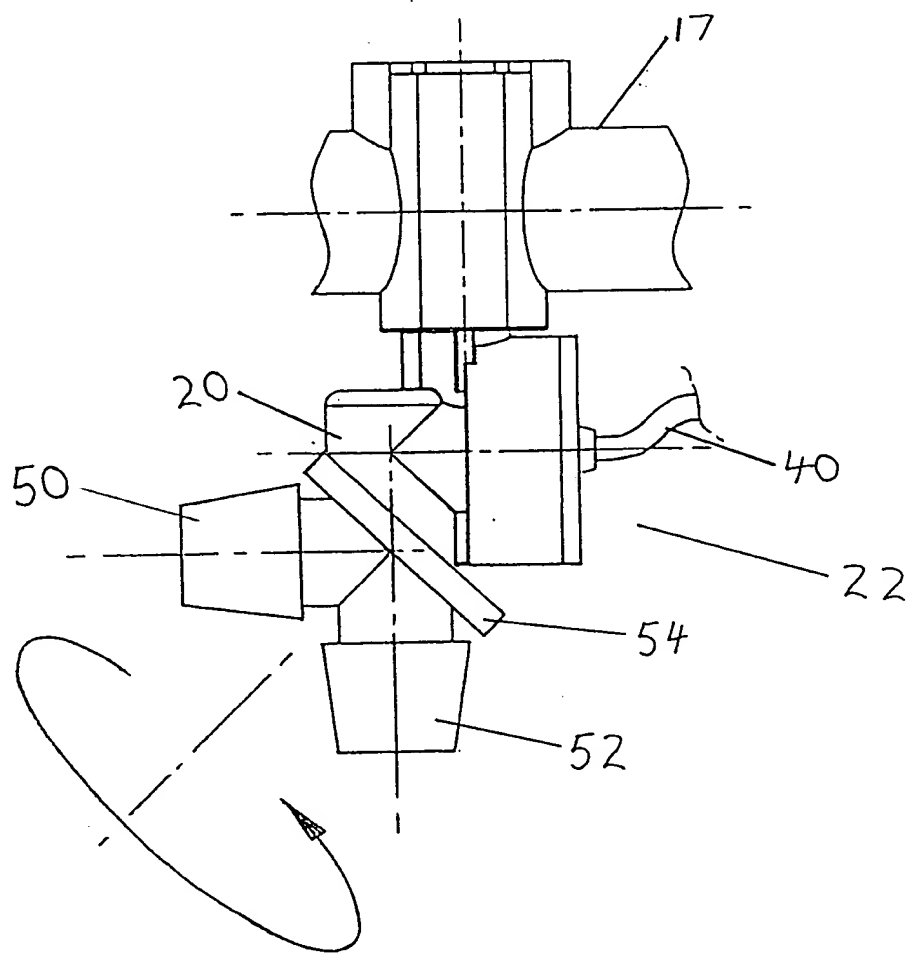


Figure 4